TTY Forum Test Results Summary

Technology: CDMA / TDMA

Contribution Date: 99.05.18

Contribution Number: 99.05.18.13

Contributing Company: Lucent

Summary: This contribution provides a progress report on Lucent's TTY/TDD Audio Path Solution. Test results in this contribution continue to show 0% CER for the Lucent solution.

Progress Report on Lucent's TTY/TDD Audio Path Solution

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Vocoder Simulations w/ TTY/TDD Solution

CDMA

- IS-127 EVRC
- IS-733 13K Vocoder

Features

- Fully Interoperable
- VCO/HCO
- Variable Rates

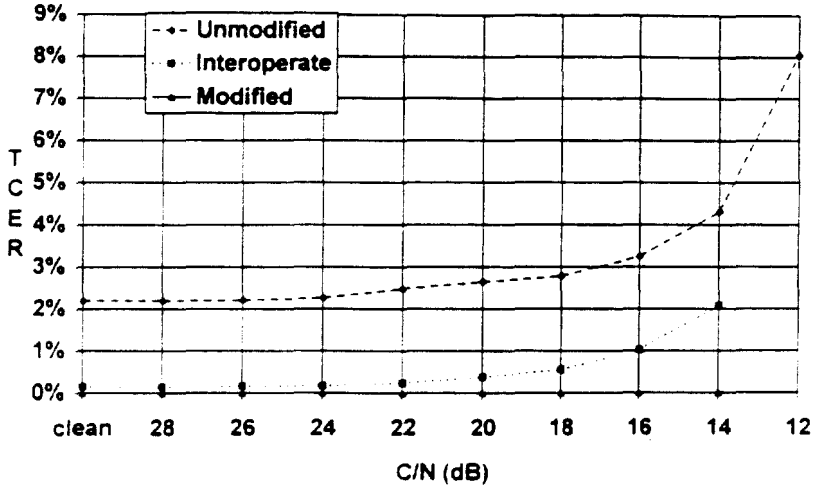
TDMA

- TIA/EIA 136-410 (formerly IS-641)

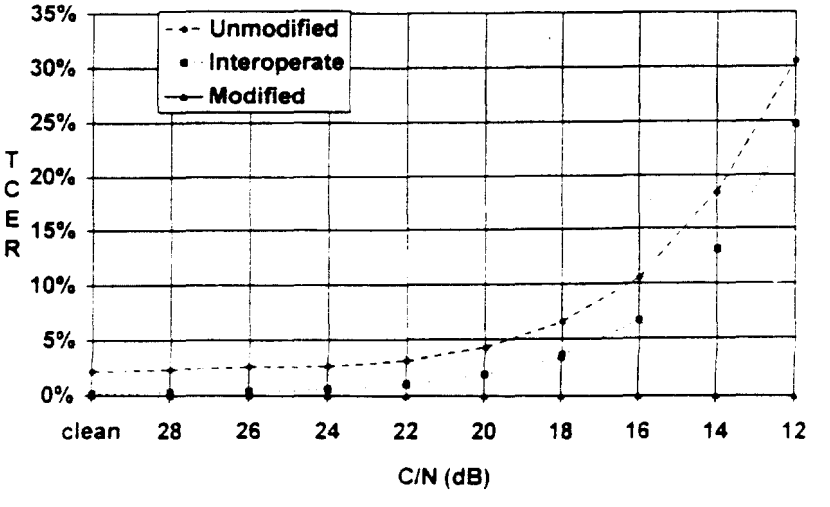
Features

- Fully Interoperable
- VCO/HCO
- DTX

Simulation Results: TIA/EIA 136-410 EFR Speech Codec 180 Hz. Doppler



Simulation Results: TIA/EIA 136-410 EFR Speech Codec 10 Hz. Doppler



Future Work

- **CDMA**
  - **Selectable Mode Vocoder (SMV) Competition***
- **TDMA**
  - **US1 Vocoder**
  - **TDMA-6 Half Rate Vocoder Competition***
- **GSM**
  - **GSM EFR Vocoder**
  - **GSM AMR Vocoder**

***designed for TTY/TDD compatibility**

TTY Forum Test Results Summary

Technology: CDMA / Voice & Data

Contribution Date: 5/20/99

Contribution Number: 99.05.20.15

Contributing Company: Motorola

Summary: This contribution outlines the solution Motorola proposes for both a Voice (Through the Vocoder) and a Data (Circuit Switched) solution.

For the Data solution, Motorola proposes building an inter-working in conjunction with 3Com The solution requires building an inter-working function data solution in the network to handle TTY calls. The contribution details how a call, originating in a mobile environment would be passed from a computer or some digital format, through an RS-232 connection to a CDMA handset, where it would then be broadcast to the inter-working function in the network. The inter-working function in the network acts as a translator of the digital code to the TTY 45.45-baud Baudot tones that the "landline" TTY devices speak.

For the Voice Solution, the contribution outlines an alternative treatment of the Baudot tones through the vocoder. Motorola proposes slowing the transmission rate of the CDMA frames in order to set up a "Secondary Channel" for a TTY call. The contribution also compares the Motorola solution with the Lucent "No Gain" solution.

MOTOROLA

Motorola Solutions for TTY/TDD in CDMA Cellular Networks

Data Solutions

and

Vocoder Solutions

CDMA Data Solution

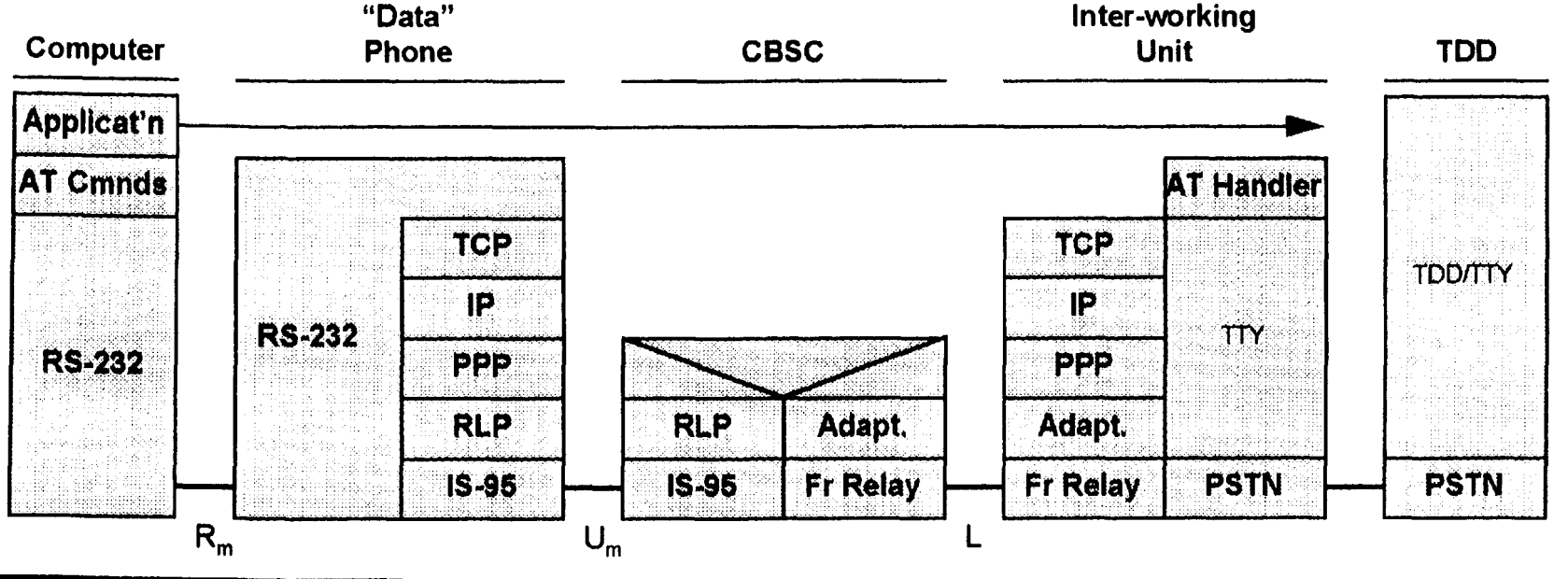
MOTOROLA

- CDMA does not transport modem tones through the air interface -- it transports RS-232 serial data to the inter-working function
- The Inter-working Function provides the modem communications for the computer connected to the cellular phone.
- To support TTY over CDMA, the appropriate protocol is being added to the Inter-working Unit.
- Motorola is building solution in conjunction with 3Com
- It will provide ability to connect an RS-232 based Data Terminal Equipment to a CDMA data-capable phone and place and receive calls from a TDD.
- The interconnection between existing TDD and the CDMA phone is still a work in progress.
- Software Upgrade to existing Inter-working Units

Data Transmission is Very Reliable

MOTOROLA

- Data is transported inside TCP/IP packets that are on top of the Radio Link Protocol Layer.
- Error recovery and packet retransmission is taken care of by the TCP/IP layer.
- Bit error rates can be as low as $1x10^{-6}$



V.18 Solution for E911/TDD

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What We Are Doing

- Currently Support:
  - V.21 - European 300 baud
  - Bell 103 - 300 baud
- Adding Baudot
  - 45.45 baud Baudot
- Adding AT Command
  - Defined in IS-707 Standard
- FOA Date 20 Sep 99
- GA Date 15 Dec 99

What We Are NOT Doing

- Bell 103/V.21 at 110 Baud
- European Deaf Telephone
- DTMF; V.23
- 50 baud Baudot
- Voice/Hearing Carryover
  - Voice-Data Toggle is feature candidate 2H00, a work in progress.
- Passing voice signals
  - Option to send "VOICE" status code

Mobile Originated E911/TDD Call

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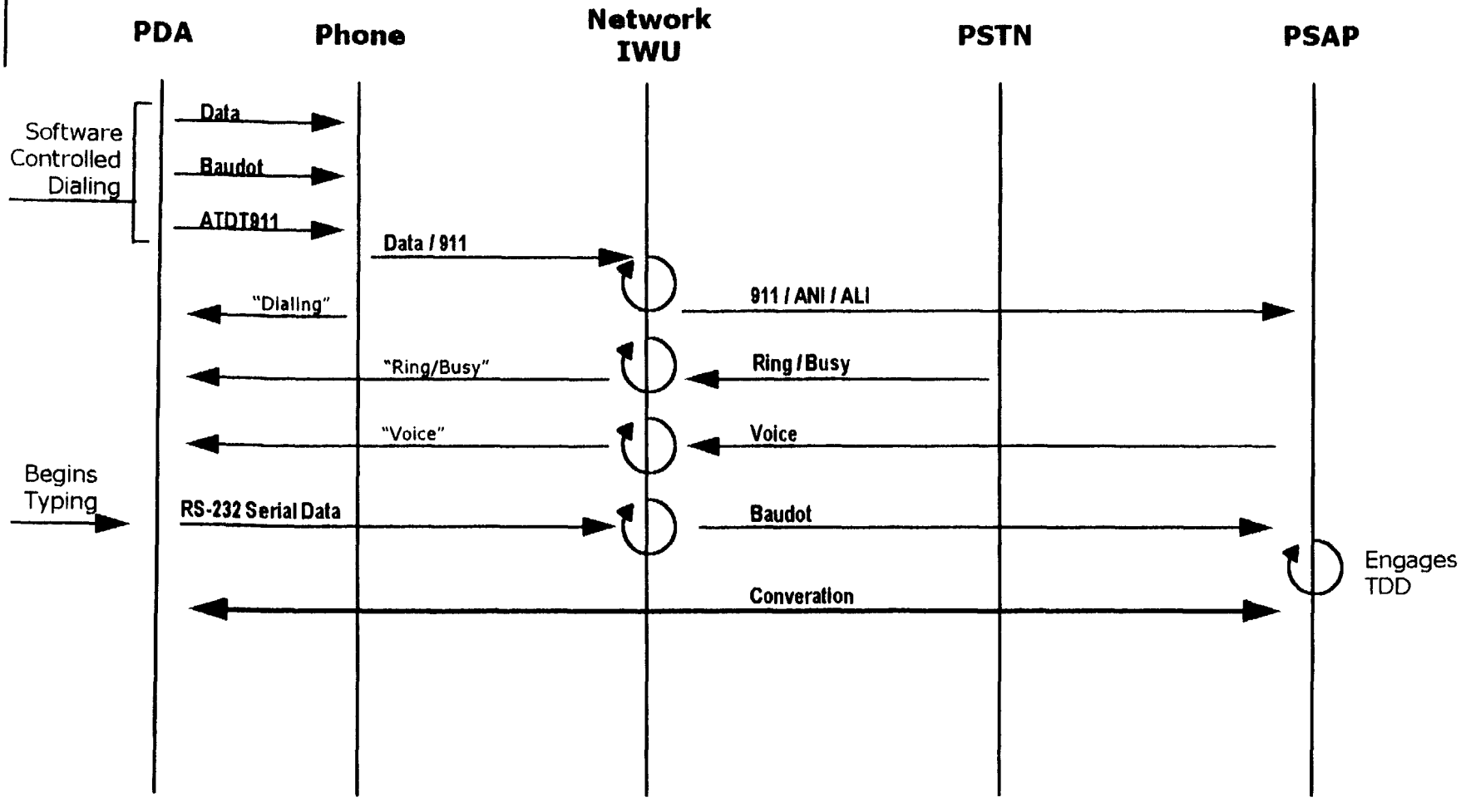

Motorola Vocoder-based Solution

The CDMA Frame

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- Frame is a standards-defined block of data used for transmitting
  - digitized voice
  - signaling information
  - short messages
  - fax and data signals
- Frames can be variable sizes
  - 1/8, 1/4, 1/2, and Full Rate are common sizes
  - Smaller frames mean more callers per cell site
- CDMA Frame is 2ms shorter than TTY character, but carries much more information.
- Two types of frames: Primary and Secondary.

Motorola "Secondary Channel TTY"

MOTOROLA

Transmitting Side

- Pre-filter identifies Baudot start bit
- Vocoder is forced to 1/8th Rate frames with null traffic while prefilter determines character
  - Silence for duration of first character
- Character sent in secondary channel
- Subsequent characters sent along with previous characters
- Voice instantly cancels prefilter, and resumes Vocoder

Receiving Side

- Stops Vocoding because receiving null primary traffic
- Sees Baudot formatted data in secondary channel
- Uses table to send vocoder reference for character

Details

- If delay between characters is long, send 3 times with same sequence number.
- Use history to identify lost characters.

Vocoder Based Solutions

MOTOROLA

Motorola

- Have Tone Detection Software Identify Baudot
- Begin sending "voice silence" in reduced rate frames
- Send Baudot Character in Secondary Channel
- Include History
- Use Baudot Table to send signals from Vocoder

Lucent

- Have Tone Detection Software Identify Baudot
- Send a Signal to Stop Vocoding
- Zero Gain Element; send baudot as data in Gain Element
- Use Baudot Table to send signals from Vocoder

Motorola Solution

MOTOROLA

- Puts Baudot Processing into higher protocol layer as opposed to being part of the Vocoder
- Vocoders remain unchanged
- Would work for 8K, EVRC and 14K vocoders
- Solution is intended to be finalized in standards, because of many implementation options.
- Voice/Hearing Carryover is automatic.

TTY Forum Test Results Summary

Technology: CDMA

Contribution Date: 99.09.08

Contribution Number: 99.09.08.16

Contributing Company: Lucent

Summary: This contribution is the slide presentation given by Dr. Steven Benno and Daniel Pratt. This contribution was presented along with an actual working demonstration of the No Gain solution.

The contribution outlines the technical merits of the solution as well as updates the Forum as to the progress the standards bodies have made in relation to the CDMA standard. Additional standards work is being in the TDMA arena.

The projected release date for this feature is December 15th, 2000.

Lucent Audio Solution for TTY/TDD in Digital Wireless Communications Demonstration

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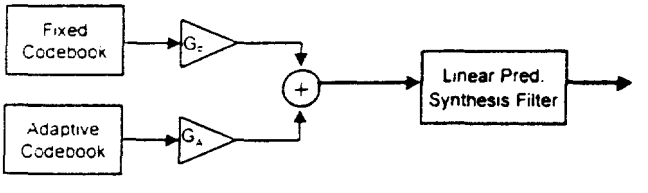
Speech and Audio Processing Technology

Background: Lucent TTY Solution

- Detect TTY Characters at Encoder
- Zero Adaptive Codebook Gain
- Transmit TTY Information from Encoder to Decoder in Adaptive Codebook
- Decoder Regenerates Baudot Code



TR45.5 CDMA Standards Work

- Feb '99: Requested PNs to modify IS-127-1 EVRC and IS-733 13K Vocoder
- Apr '99: Baseline Version
- May '99: V&V
- Jul '99: Ballot Version
- Aug '99: Publication Version IS-127-2 and IS-733-1 adopted

Lucent Product Information: CDMA

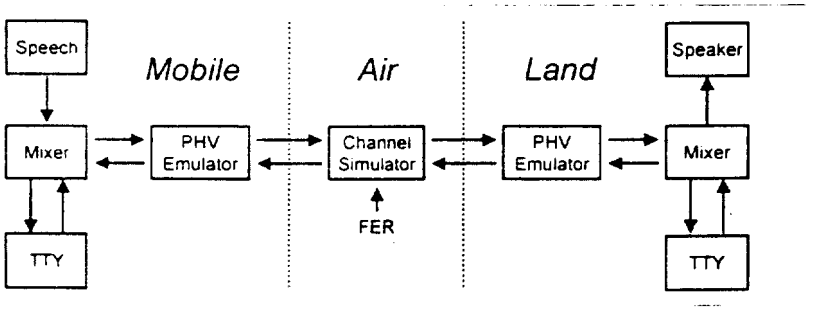
- Release Information:

  TTY/TDD Feature in Release 16.0 scheduled for Dec 15, 2000.

- Price Information:

  The TTY/TDD feature is a standard feature covered by annual maintenance fees. No separate price is associated with this feature from CDMA Software.

TTY Demonstration Setup



- Full Duplex
- TIA IS-95 Channel Simulator
- Real Time
- Production DSP Code

TTY Demonstration

- IS-127-1: Unmodified EVRC
  - 0% FER
  - 2% FER
- IS-127-2: Modified EVRC w/ TTY Solution
  - 2% FER
- IS-127-1: Unmodified EVRC
  - 20% FER
- IS-127-2: Modified EVRC w/ TTY Solution
  - 20% FER